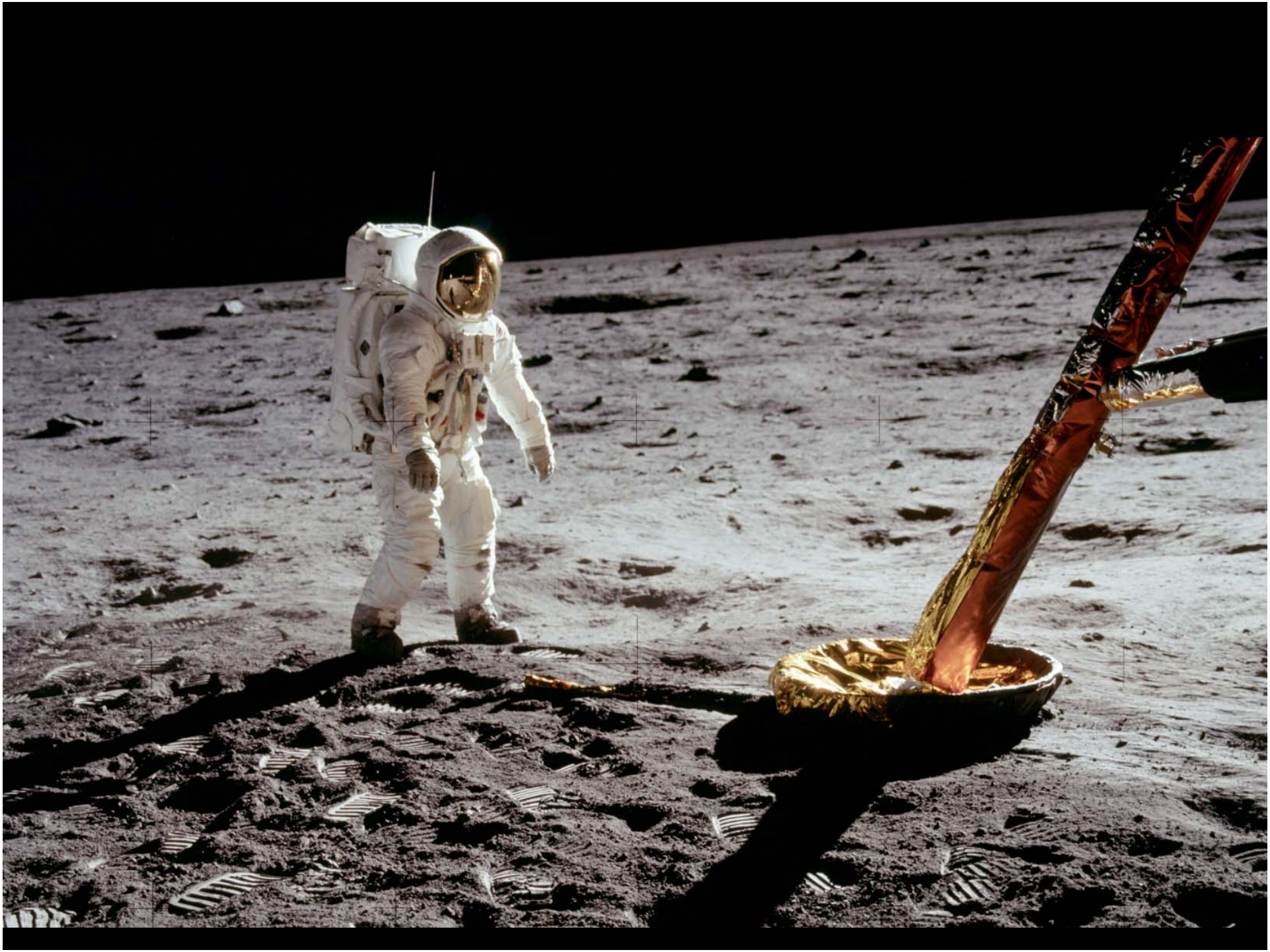
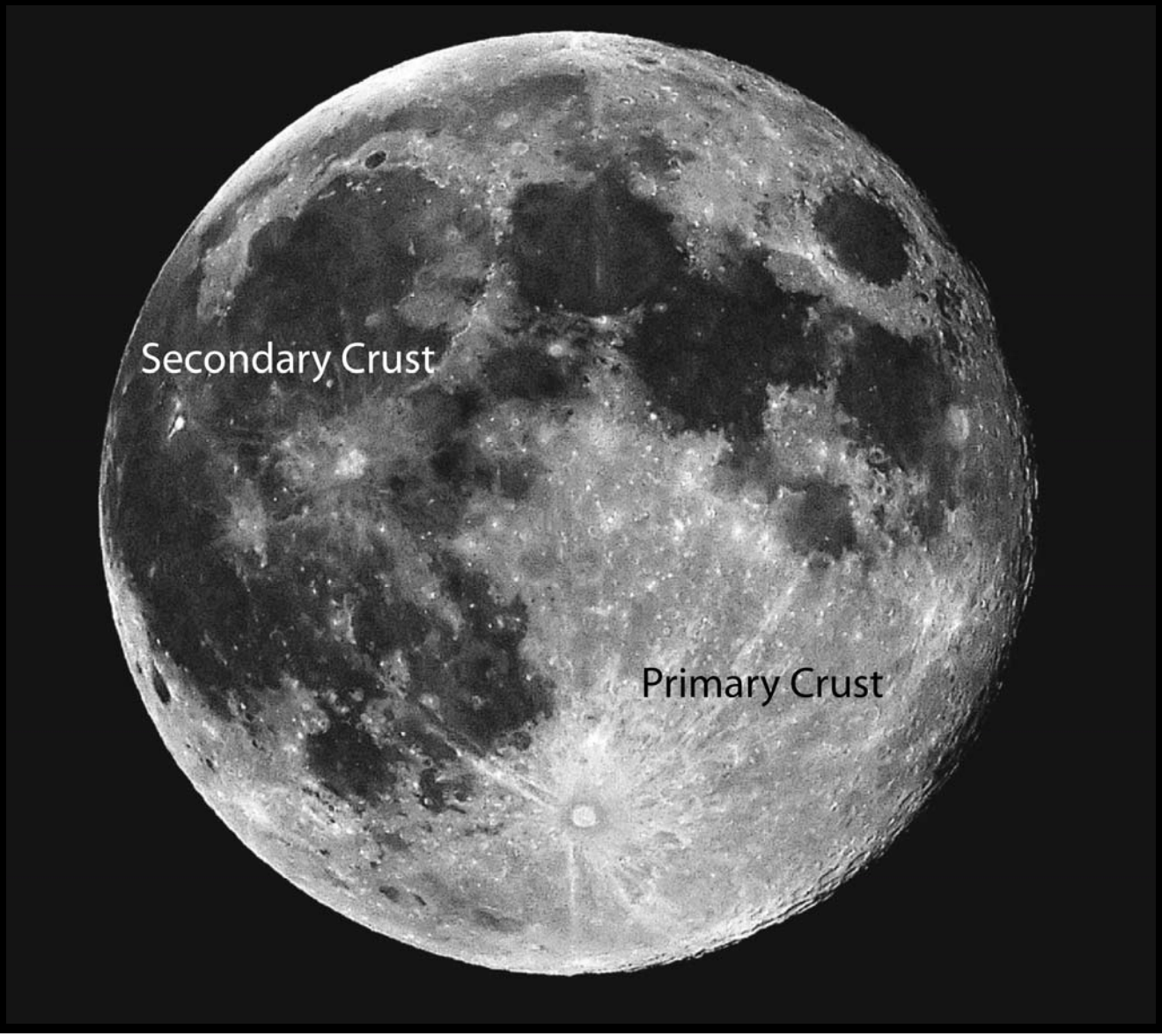
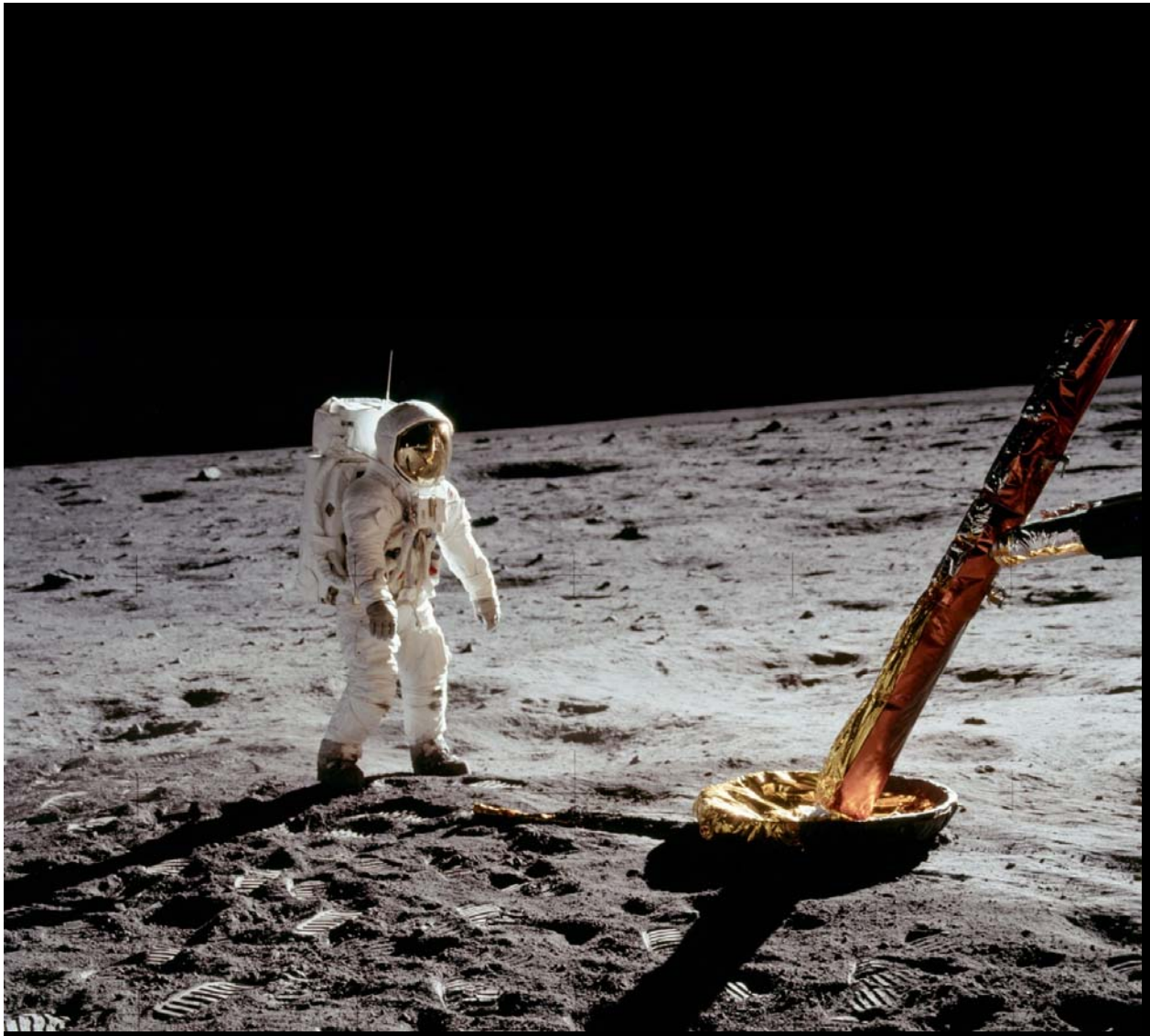
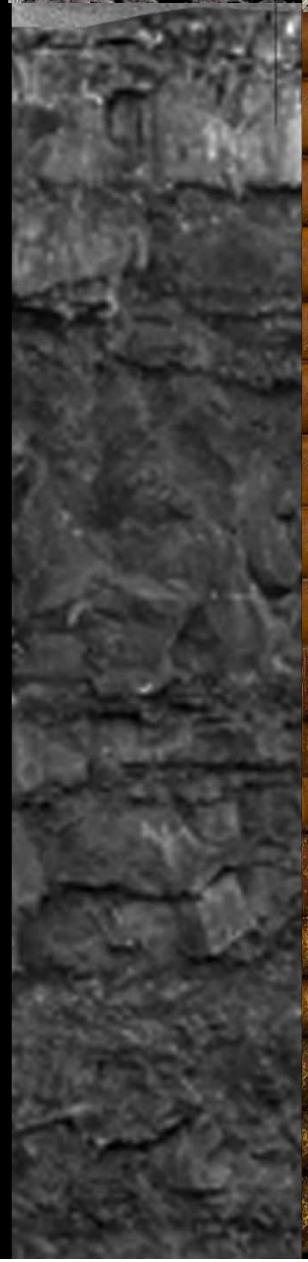
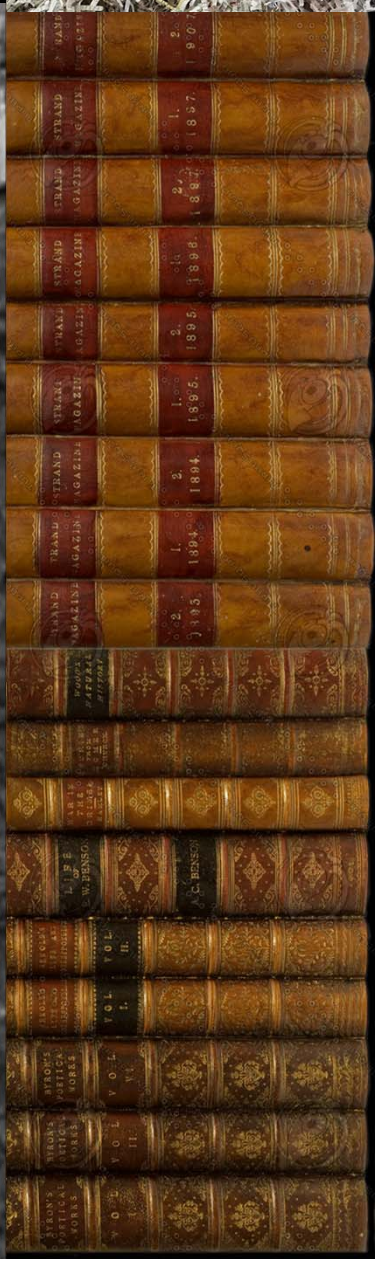


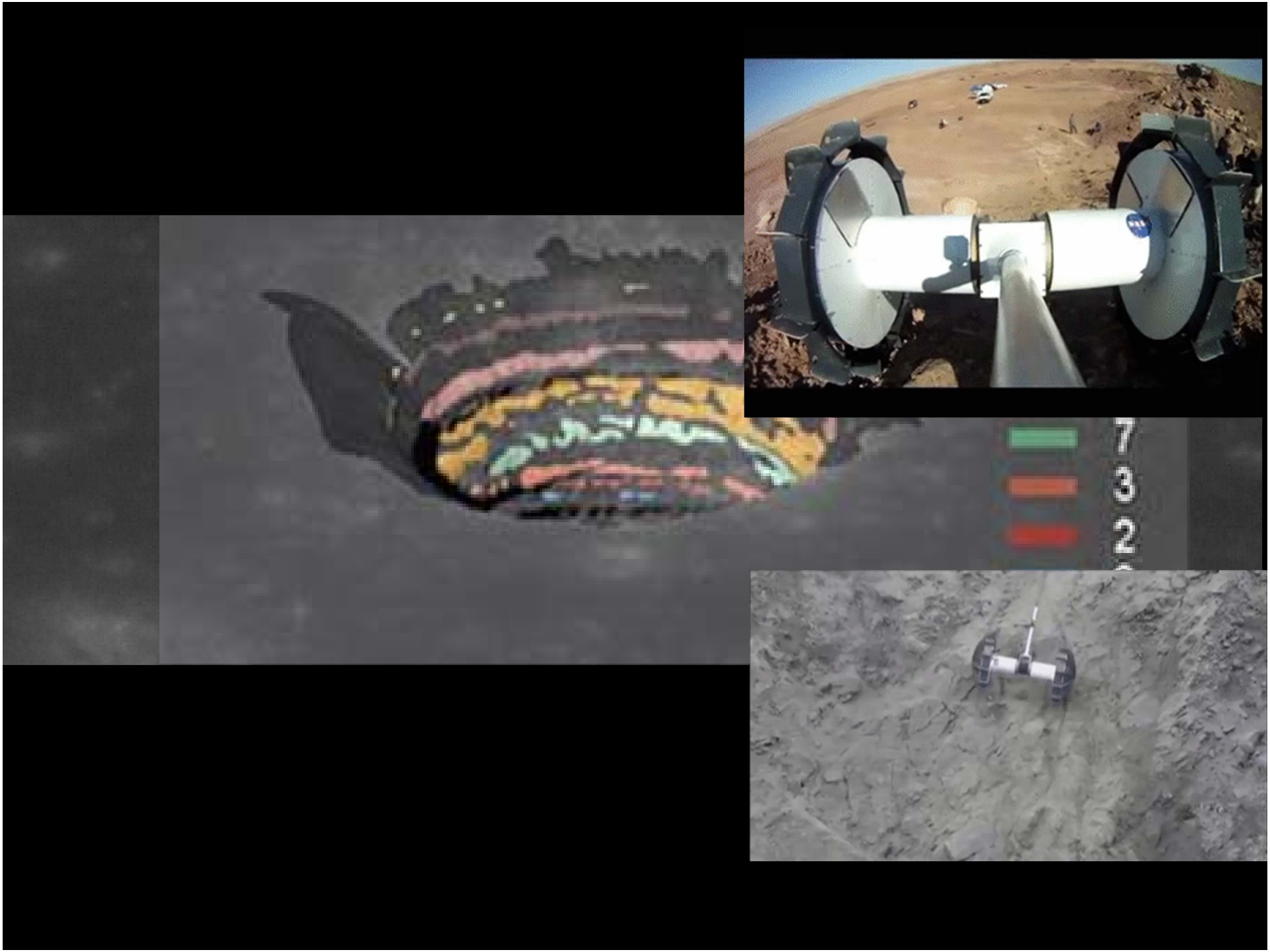
Secondary Crusts: A Fundamental Planetary Building Block

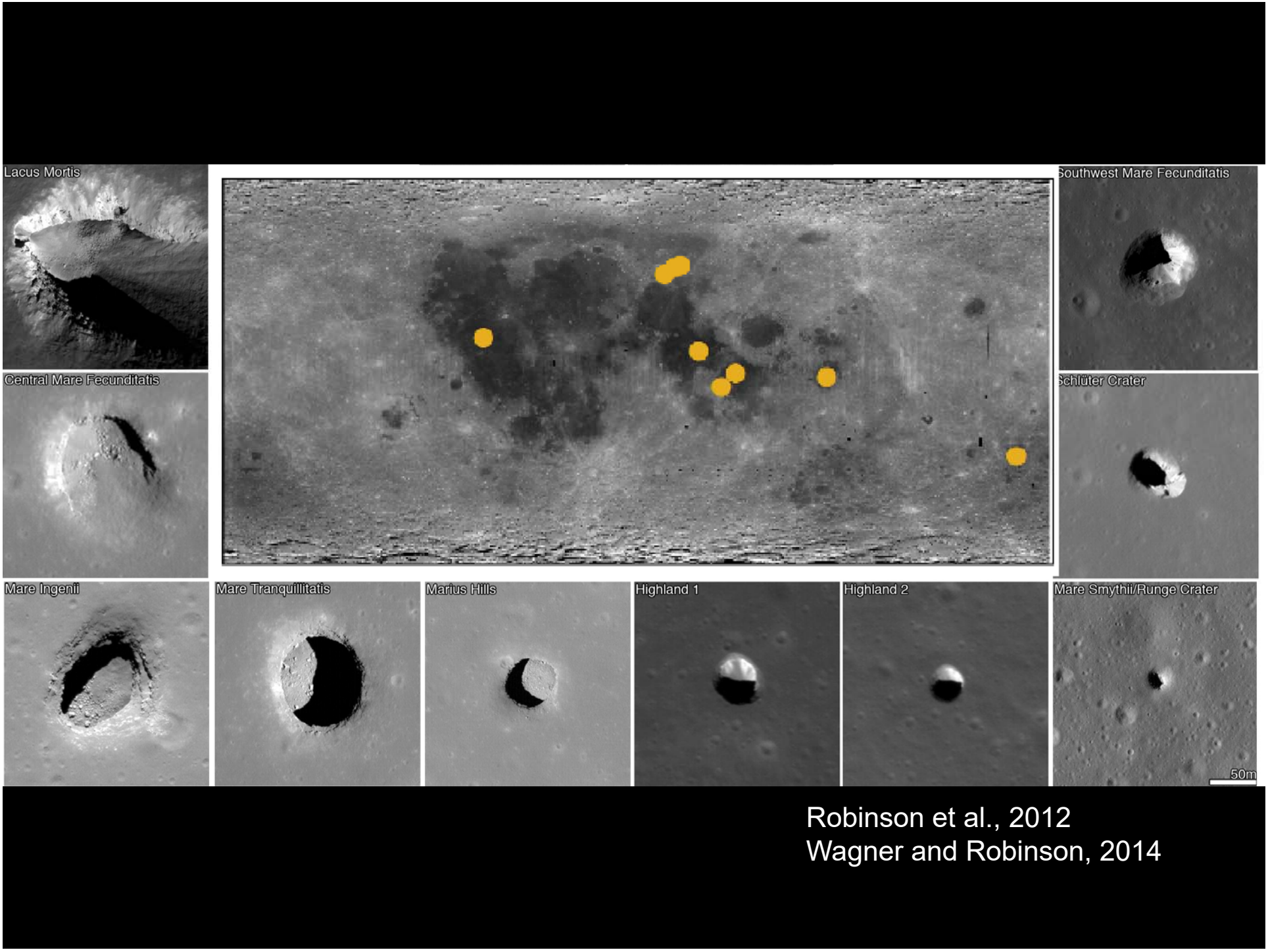




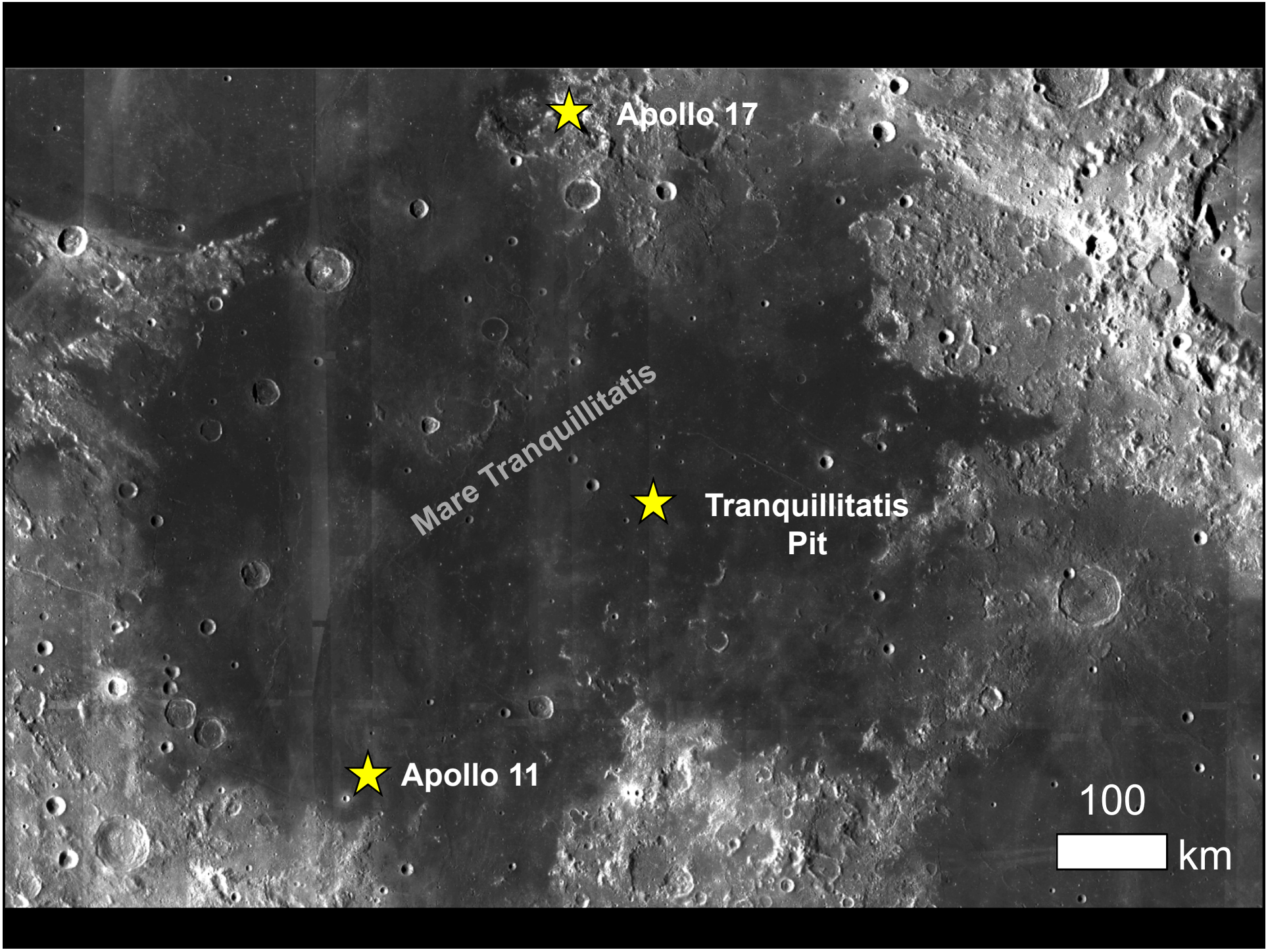





7
3
2



Robinson et al., 2012
Wagner and Robinson, 2014


Apollo 17
Mare Tranquillitatis
Tranquillitatis Pit
Apollo 11
100
km

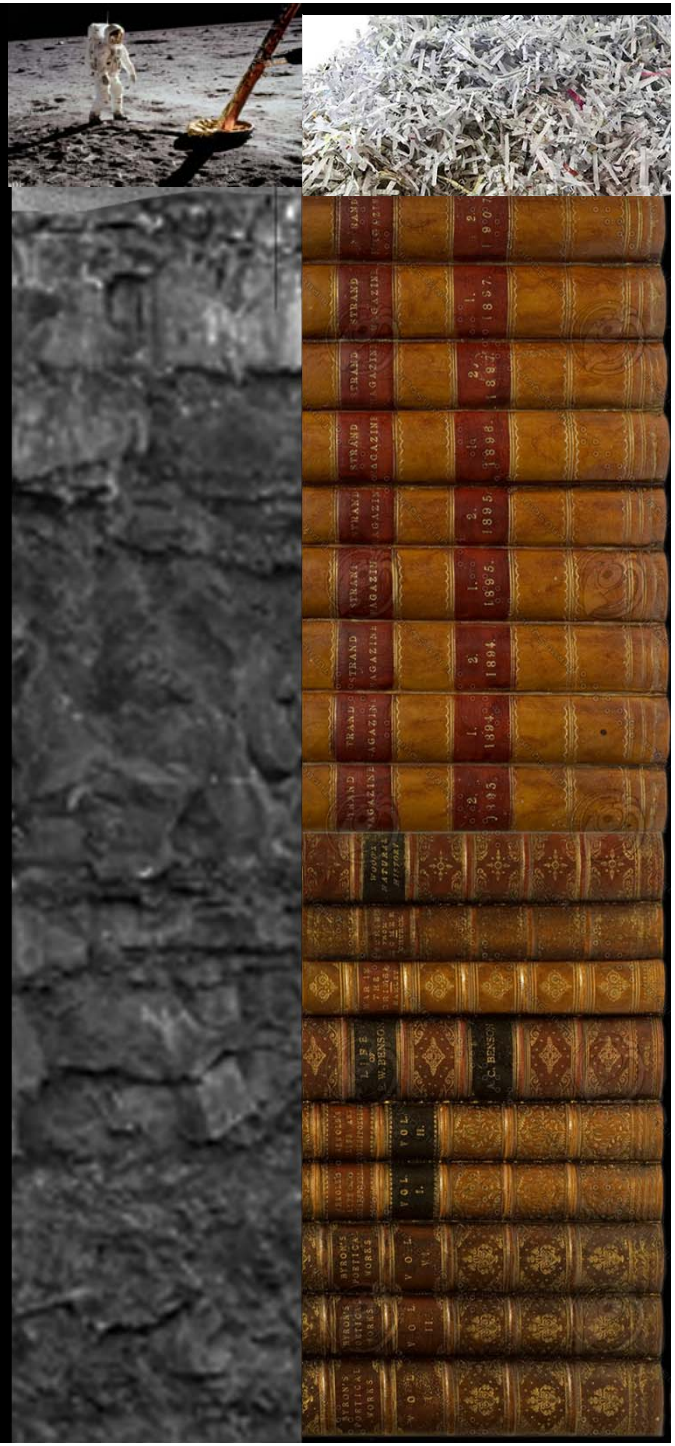
Return to the Sea of Tranquility

…and dive beneath!

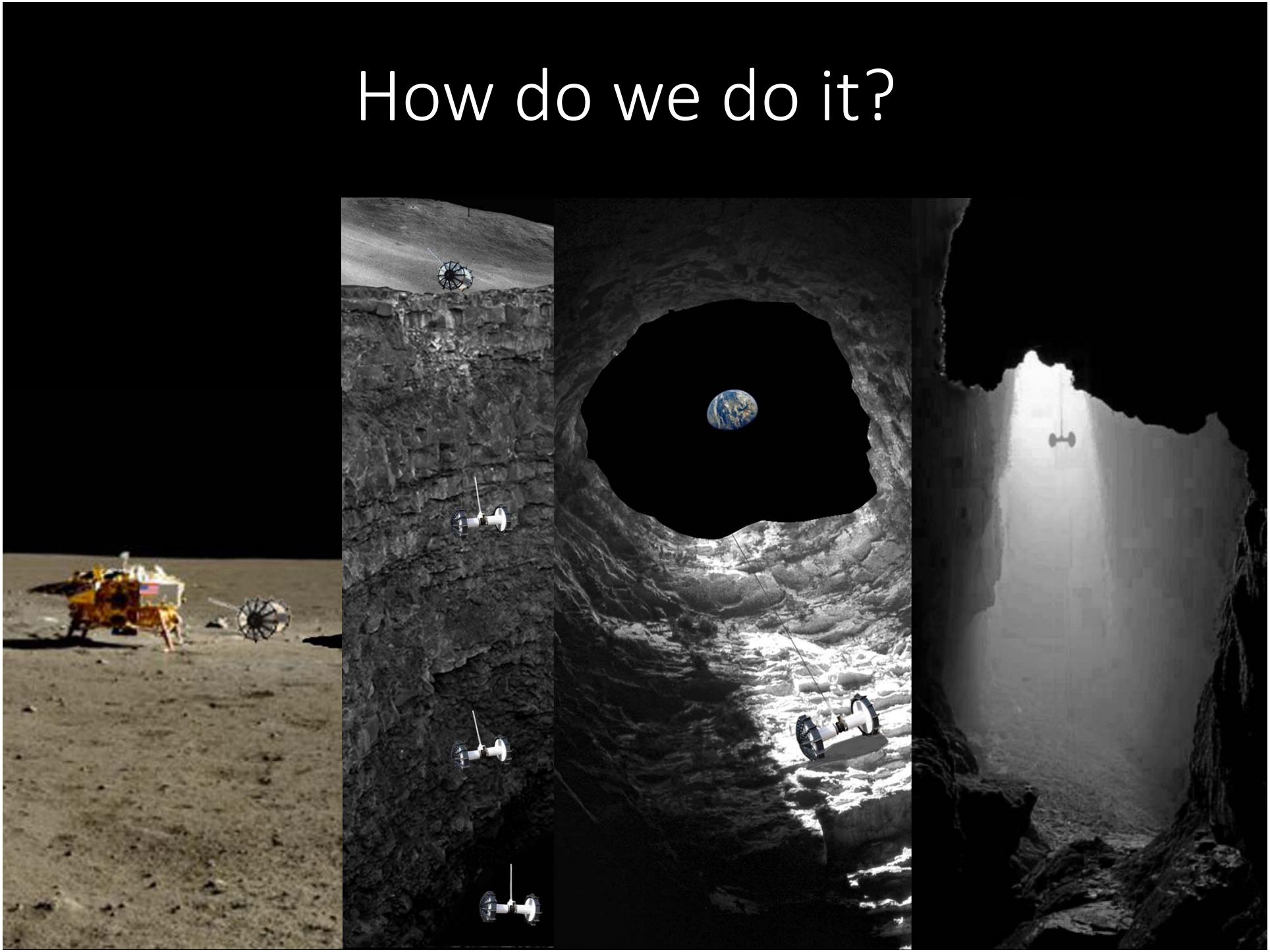
1. To determine how the regolith formation process transforms the secondary crust into what we see from orbit and sample on the surface.

2. To understand how the secondary crust was emplaced (whether by catastrophic, turbulent flood lavas or incremental, inflated or complex flows).

3. To understand where the mare basalts came from and the diversity of their source regions.



How do we do it?



A Simple, Effective Payload:

Context Cameras:

- Provides **context imaging** for **lava morphology and layer thickness**

APXS (Alpha Particle X-ray Spectrometer):

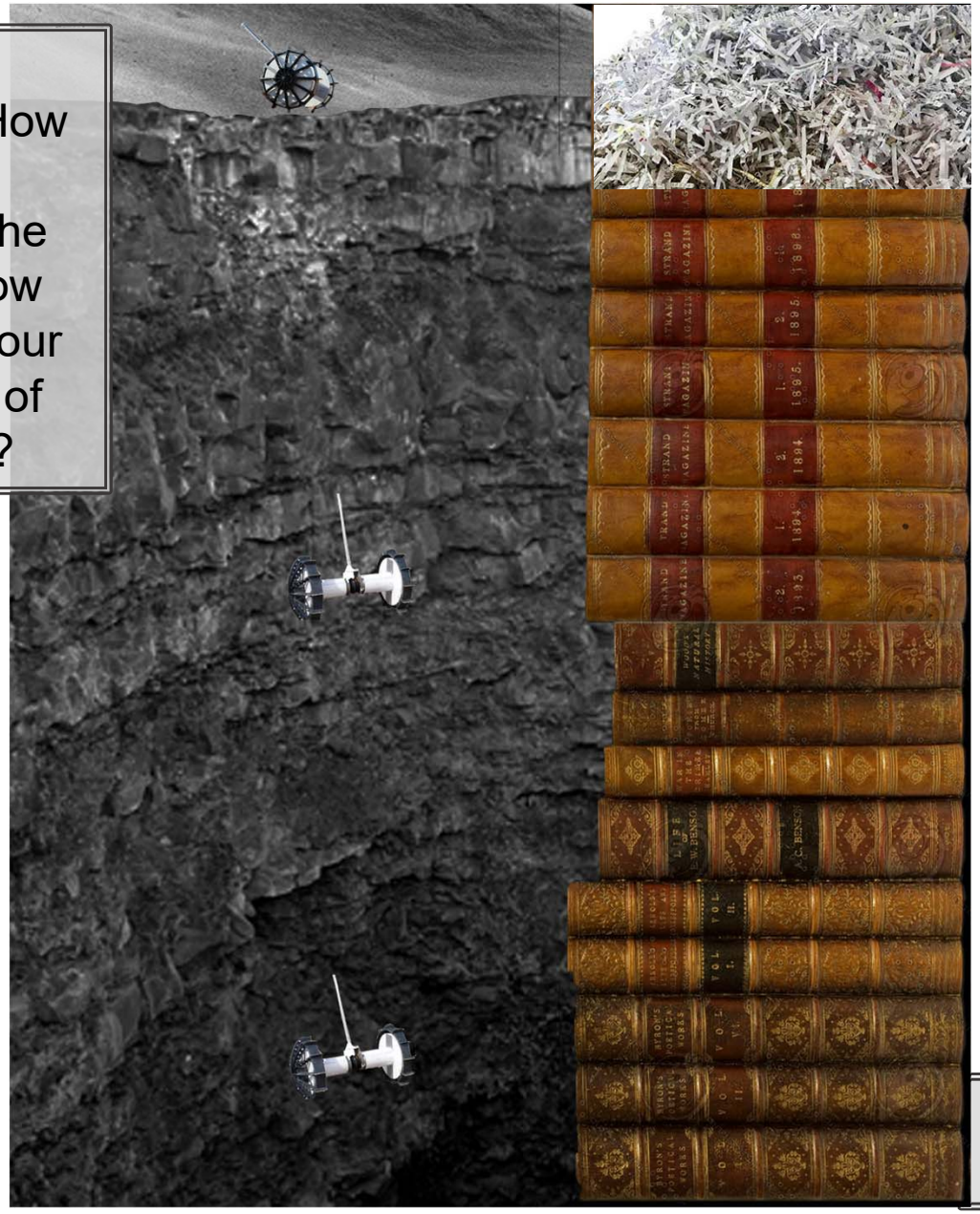
- Provides **elemental chemistry** to understand the **composition** and **evolution** of the lava layers, and their connection to the overlying regolith

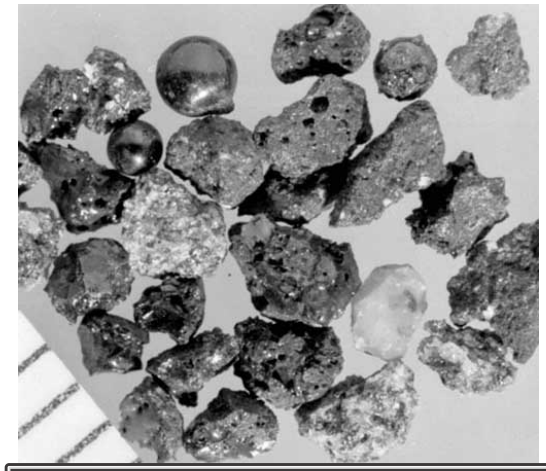
Multispectral Microimager:

- Provides **microimaging** for **vesicles, flow textures, phenocrysts,** and **mineralogy.** Provides fine-scale (18 um) mineralogic context for the APXS.

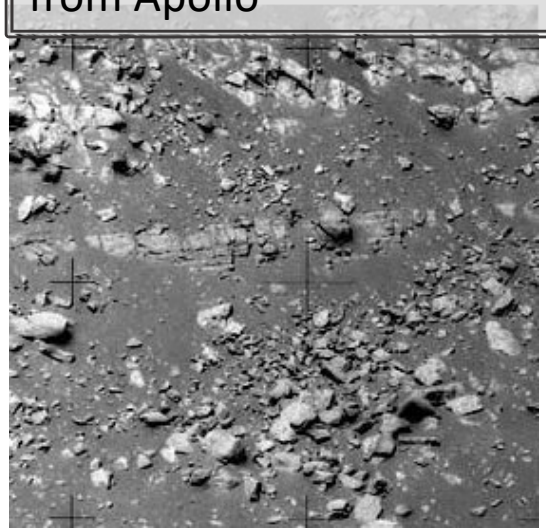
What Measurements Do We Need to Take to Satisfy Our Objectives?

1. Regolith Formation: How is the regolith formed from the substrate? How does it affect our interpretation of the substrate?





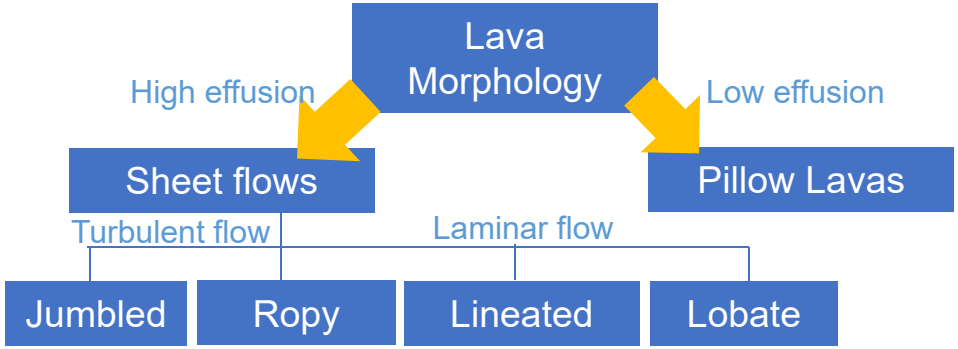
Mixed breccias and glasses from Apollo

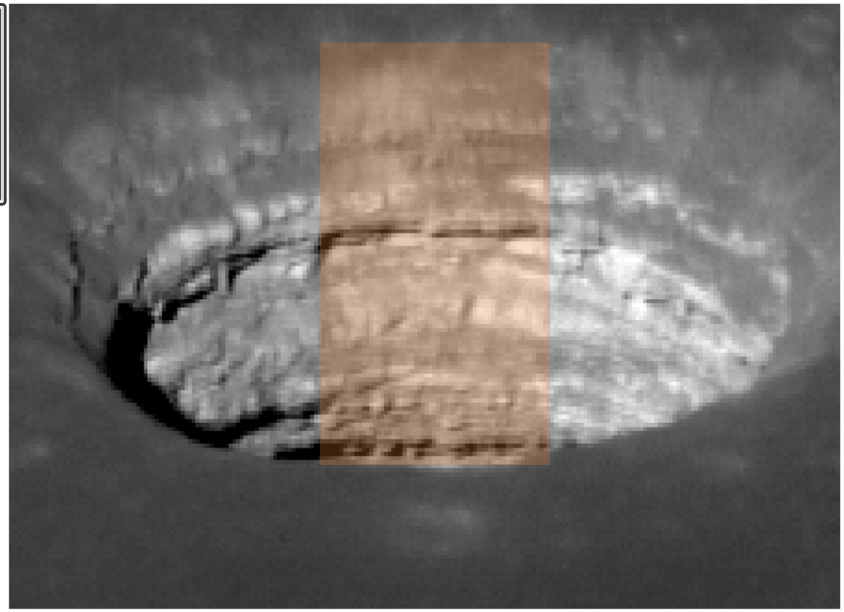


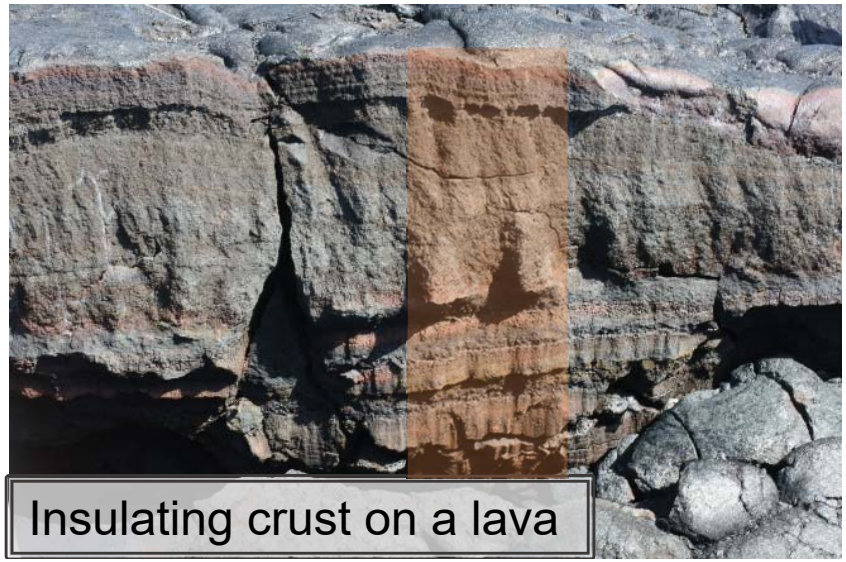
Broken up bedrock glimpsed by Apollo 15 from 1600 m

What Measurements Do We Need to Take to Satisfy Our Objectives?

2. Emplacement:
The lava's morphology and chemistry tells us how it flowed (turbulently or laminarly)





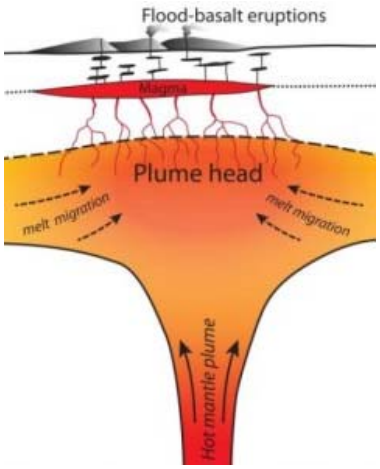


Insulating crust on a lava

Lava tubes and flow lobes in cross-section

What Measurements Do We Need to Take to Satisfy Our Objectives?

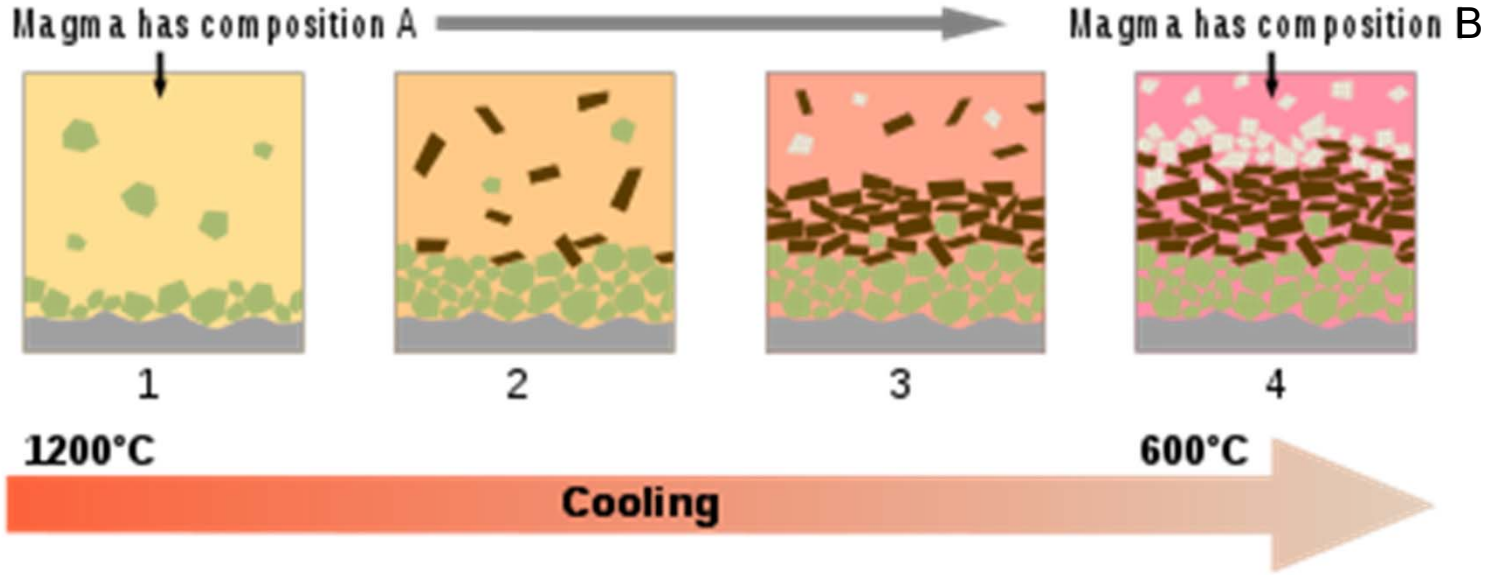
3. Origins: The chemistry and mineralogy tell us how long the eruption was sustained, as well as information about the deep interior

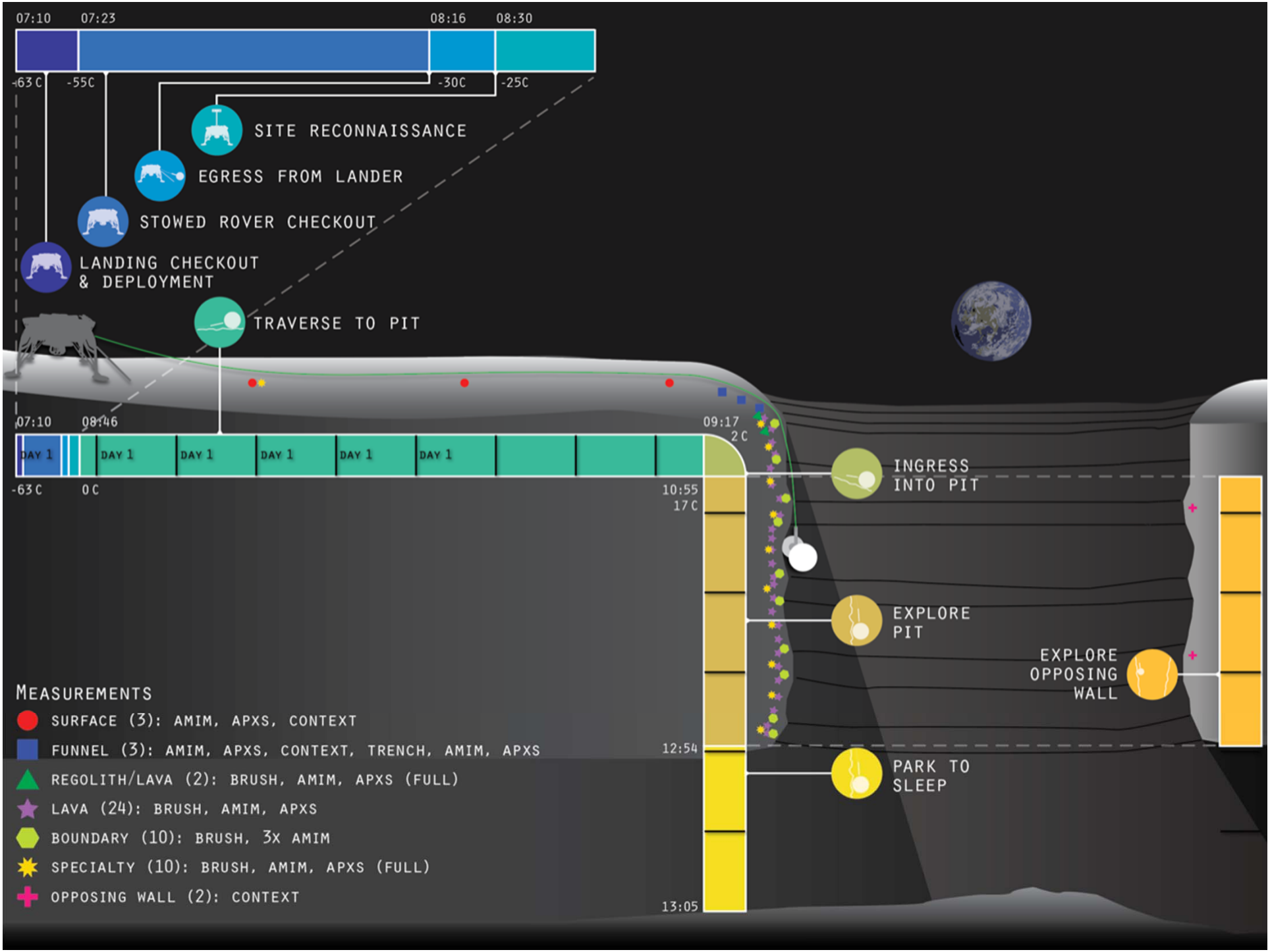


Even within these groups, the compositions of high-Ti basalts vary significantly from sample to sample. Explanations for these differences are complicated by the fact that virtually all mare basalt samples were collected as loose blocks in the regolith, and no identifiable lava flows were sampled directly on the lunar surface (although sampling at the Apollo 15 site came within a few meters of lava bedrock). Nevertheless, studies of terrestrial lava flows suggest that the observed variations from sample to sample reflect variation both within and between individual lava flows. -The Lunar Sourcebook

Elemental Abundance of major elements

Mineralogy, crystals, vesicles




07:10
07:23
08:16
08:30
-63 C
-55C
-30C
-25C
SITE RECONNAISSANCE
EGRESS FROM LANDER
STOWED ROVER CHECKOUT
LANDING CHECKOUT
& DEPLOYMENT
TRAVERSE TO PIT
07:10
08:46
09:17
2 C
DAY 1
DAY 1
DAY 1
DAY 1
DAY 1
DAY 1
-63 C
0 C
10:55
17 C
12:54
13:05
INGRESS
INTO PIT
EXPLORE
PIT
EXPLORE
OPPOSING
WALL
PARK TO
SLEEP
MEASUREMENTS
SURFACE (3): AMIM, APXS, CONTEXT
FUNNEL (3): AMIM, APXS, CONTEXT, TRENCH, AMIM, APXS
REGOLITH/LAVA (2): BRUSH, AMIM, APXS (FULL)
LAVA (24): BRUSH, AMIM, APXS
BOUNDARY (10): BRUSH, 3X AMIM
SPECIALTY (10): BRUSH, AMIM, APXS (FULL)
OPPOSING WALL (2): CONTEXT

A balance of low risk and high risk for a high reward

- We know what we're looking for
- We can see where to find it
- We are bringing instruments that we know how to use


• Direct measurements of basalts
• Direct observation of the regolith/bedrock interface
• Direct observations of paleoregolith layers
• Connection back to orbital datasets
• A "new dimension" of lunar science
Context!
Context!
Context!
Context!
Context!
Context!
Context!
Context!
Context!
Context!
Context!